Appendix E

Botanical Species Process Paper

October 1998

Background

Botanical species diversity is dependent on the variety of habitats found throughout the National Forest matrix. Ross and Chambers (1988) estimate that 95% of the biodiversity in forests from the western Cascades are found in special and non-forested habitats. Special habitats are defined as those habitats that are not part of the dominant (coniferous) forest matrix. Examples include areas such as forested wetlands (hardwoods and swamps), springs, meadows and rock outcrops. Most of the Regional Forester's sensitive species for Region 6, Willamette National Forest, and other rare species whose distributions are tracked to ensure their viability (NFMA direction) grow in meadows, rock gardens, rock outcrops and riparian areas.

Roads have historically been built along riparian lowlands and ridgelines for both economics and feasibility. All of the major highway and many scenic byway corridors are built adjacent to major waterways: North Santiam (Highway 22), South Santiam (Highway 20), McKenzie (Highway 126), South Fork Middle Fork Willamette (21), North Fork Middle Fork Willamette and South Fork McKenzie (15) and Salt Creek (highway 58). Midslope roads intersect riparian areas as they travel upslope. Roads often intersect with special habitats along ridgelines. These areas are often rocky, with little soil development; factors which favor development of dry meadows or rock gardens rather than a forest. Not only are these habitats situated where roads are most easily built, but it is also presumably cheaper to build through a rock garden than a forest. Many of these habitats have had fill placed on top of existing habitat as roads are built through them. The resulting changes in drainage patterns, changes in soil composition, and introduction of noxious weeds from roadside shoulders may cumulatively result in significant alteration of the existing plant communities.

Other botanical species unique to the Pacific Northwest are species on the "survey and manage" list. These species were elevated in importance by their inclusion in Table C3 of the ROD (USDA and USDI, 1994a). These species are largely non-vascular plants (mosses and liverworts), lichens and fungi. The importance of these species to the health of ecosystems is just being recognized. The majority of these species are found in mature to late-successional forests. Intact forests have substrates and microclimate (temperature and humidity) preferred by these species. Several species are dependent on pristine riparian or aquatic conditions. Roads create openings to interior forest habitats, reducing the quality of the habitat. Fragmentation of habitat creates conditions which many species may not survive.

The final botanical feature affected by roads is noxious and invasive nonnative weeds. The Oregon Department of Agriculture's Weed Control program began mapping weed infestations across the Forest in the late 1980's. In 1993, the Forest wrote an Environmental Assessment for an Integrated Vegetation Management Program (LRMP standard and guideline) that directs the Forest to use all available control methods found in the EA, based on site-specific analysis. The EA is tiered to the Regional EIS for Managing Competing and Unwanted Vegetation. The preferred alternative is prevention of noxious weed movement and infestation. The second priority is control of new invaders. On this Forest, knapweeds, toadflax, giant knotweed, false brome and new infestations of evergreen and Himalayan blackberry are new invaders and are targeted for treatment.

Roads are the vectors disseminating most of our weeds throughout the Forest. Most roads are maintained, creating early seral habitat, devoid of competing vegetation, for weed establishment. Without immediate revegetation of road cutbank and shoulders following construction, weeds establish. Vehicles, animals, and machinery move noxious weeds from place to place. Weed populations are found in dispersed campsites, hunting camps, trailheads and timber harvest landings.

Maintenance of roads also contributes to movement of weed seed and propagules, especially along the crest of the Cascades. Knapweed is our largest problem and it is largely referred to as a “road runner”. It has very light seed similar to that of a dandelion, which may easily be transported on the undercarriage of vehicles in soil or debris. This species seems to be moving from population centers on the east side of the Cascades via State highways through the Forest down into the Willamette Valley. The largest concentrations of this weed are along the major highway corridors, 22, 20, 126 and 58. Populations on the 126 corridor seem to be spreading at an alarming rate off the major highway along Forest Service arterial roads. One factor we have been able to document is movement of weed seed from cinder pits (waste disposal areas) used for icy highways in the winter. This species is highly drought-tolerant and can survive in areas of minimal soil such as cinder or on road shoulders.

Process description and Documentation

1. ***How do roads change special, mostly nonforested, plant habitats?***

- ***How and where do roads affect special and unique habitats (e.g. meadows and rock gardens)?*** Forest and project scale

This question would ideally be answered using a GIS layer for special habitats and intersecting it with the roads layer. Unfortunately, a forestwide special habitat layer has yet to be consolidated from Ranger District layers (which are in various stages of completion). In the absence of this forestwide tool (which should be available summer 1999), we may look at the nonforested habitats in the forestwide vegetation layer (Vegis). Conclusions from this query will be very general as the only habitats featured in Vegis are greater than 1 acre and we know that a large percentage of habitats across the forest are smaller than this. Also, very general habitat identification (for example shrubland, wetland) is used.

To get a more detailed description of the effects previously constructed roads have had on special habitats, one may use data from the three Watershed Analyses completed on Lowell Ranger District of the Willamette National Forest: Fall Creek, Winberry and Lookout Point Reservoir (note: most Watershed Analyses on this Forest have used this process). The special habitat layer manuscripted from orthographic photos, hand digitized into GIS, and attributed as to non-forested plant association/special habitat type (see Dimling and McCain, 1996) was used to overlay roads.

- ***How do roads impact reserved lands (Late Successional Reserves and Riparian Reserves) which are habitat for rare and unique species?***

- ***What late-successional-related species are found adjacent to roads and how is their habitat affected?*** **Forest scale**

This question can be answered using the two forestwide layers for survey and manage species (survmanage and allotropa) and intersecting them with roads that are buffered by 120 m (387 ft) on each side. The reason for buffering the roads by this amount is that research has shown opening of the forest can cause changes in microclimate up to 500 feet from the opening (Chen et al, 1995). This research was conducted to determine changes induced by opening up the canopy by regeneration harvest, but effects are assumed to be similar.

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2. ***How do roads affect sensitive plant species and other plant species of concern?***

- ***What species are located in habitats with high probability of impact from road building and quarries?***

This question may be partially answered using the analysis completed for Botany question #1 as most of the sensitive plants on the Regional Forester's Sensitive Plant List for Region 6, Willamette National Forest, are highly correlated with special habitats. The sensitive plant GIS layer was overlain with roads buffered by 50 feet to determine whether any intersections occur. And finally, we may use the results of our Willamette National Forest LRMP Monitoring question # 16.4 that asks whether any sensitive plant species have been adversely affected by management actions.

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3. ***How does road maintenance and construction contribute to movement of noxious and undesired non-native plant species?***

- ***How and where do roads contribute to the spread of exotic species (i.e. noxious weeds)?*** Forest scale

To analyze the distribution of weeds and the contributory nature of roads to weed movement, overlay the weed infestation GIS layer with roads. There is almost a 1 to 1 correlation between movement of the new invaders and the road network.

Results and Interpretation

Special Habitats

The first part of the analysis was determining the intersection of roads with a 120 meter buffer on the forestwide special habitat layer (map ef1a). Table 1 illustrates the percentages of habitats that are affected by roads on a rough scale using polygons of one acre or larger.

A significant number of special habitats have been affected by roads. The number of affected habitats presented is deceptively low as special habitats counted include those in roadless and Wilderness areas where there are no roads to impact special habitats. Thus this analysis at the forestwide level does not accurately portray the issue.

An analysis was conducted on a forestwide scale to determine where on the landscape special habitats are most affected by roads built through them ("hot spots"). The hypothesis was that the habitats most greatly affected are often found along the ridgelines (shrub =vine maple and alder in Table 1) and in the valleys (wet meadows and ponds in Table 1). These areas are where many of the Forest roads and major highways are built. The results of this analysis showed that only 2% of affected habitats were within the top 10% of the slope and 16% of affected habitats are within the bottom 10% of the slope. This analysis disproves the hypothesis about ridgeline habitats but supports the hypothesis about riparian habitats. One would expect a random distribution to show 10% of habitats affected per 10% slope.

Table 1. Analysis of Intersection of Roads with Forestwide Special Habitat Polygons

Habitat Type	**Acres Affected By Roads**	**Total Acres Forestwide**	**Percentage of Habitats Affected by Roads**
Rock garden	25.7	1013.3	2.5
Mesic Meadow	554.3	15703.4	3.5
Dry Meadow	204.7	4344.8	4.7
Shrub	520.6	8067.8	6.4
Rock Outcrop	98	2267.5	4.3
Wet Meadow	124.6	2420.2	5.1
Talus	1151.5	43364	2.6
Pond	15.6	242.2	6.4

Hot spots were more numerous in the riparian than the ridgeline watersheds. Hot spots for ridgeline habitats affected are only in Fall Creek (27%). Hot spots for special habitats affected in riparian areas include North Santiam Downstream (53%), Willamette Middle Fork Downstream (44%), Hills Creek (33%), North Santiam Blowout-Woodpecker (29%), Willamette, Upper north Fork (23%) and McKenzie South Fork (22%), McKenzie, Minor Tributaries (14%). A forestwide analysis is the only way to portray where on the landscape these features are most affected.

Table 2 portrays the acres of special habitat impacted by roads in each sixth field watershed as a percentage of total special habitat acres. The “hot spots” are Lookout Point (85%), Hills Creek (75%), Upper North Fork, Middle Fork Willamette (58%), Quartz Creek (57%), Fall Creek (56%) , Middle Santiam (53%) , McKenzie Downstream Tribs (53%). In all these watersheds, over half of the special habitats are affected by roads.

Table 2. Special Habitats affected by Roads

Sixth Field Watershed	% Special Habitats Affected By Roads
Little North Santiam	7
Breitenbush	14
Upper Quartzville	21
Middle Santiam	54
South Santiam	32
McKenzie	27
Blue River	47
McKenzie, Downstream	53
Quartz	57
McKenzie, South Fork	27
Horse Creek	5
Fall Creek	40
Winberry	40
North Fk Mid Fk Willamette	40
Salmon Creek	20
Lookout Point	85
Salt Creek	20
Hills Creek	76
Staley	46
Upper N. Fk. Mid Fk. Willamette	58
Blowout	39
Upper N. Santiam	9

An analysis of the effects of roads on special habitats may be extrapolated from watershed analyses conducted on Lowell Ranger District. Table 3 depicts the percentage of special habitats affected by roads by habitat type. Road densities in Winberry and in Lookout Point watersheds are much higher than in Fall Creek because Fall Creek has some large unroaded areas (soils that are unsuited for timber harvest).

Table 3. Percentage of Special Habitats Intersecting Roads in Three Watersheds on Lowell Ranger District

Habitat Type	Fall Creek	Winberry	Lookout Point	Average
Rock garden	3	83	37	41
Mesic Meadow	3	20	84	36
Dry Meadow	6	26	53	28
Shrub Talus	1	0	53	18
Rock Outcrop	5	0	32	12
Hardwood	2	0	14	5
Wet Meadow	8	0	0	3
Pond	8	0	0	3

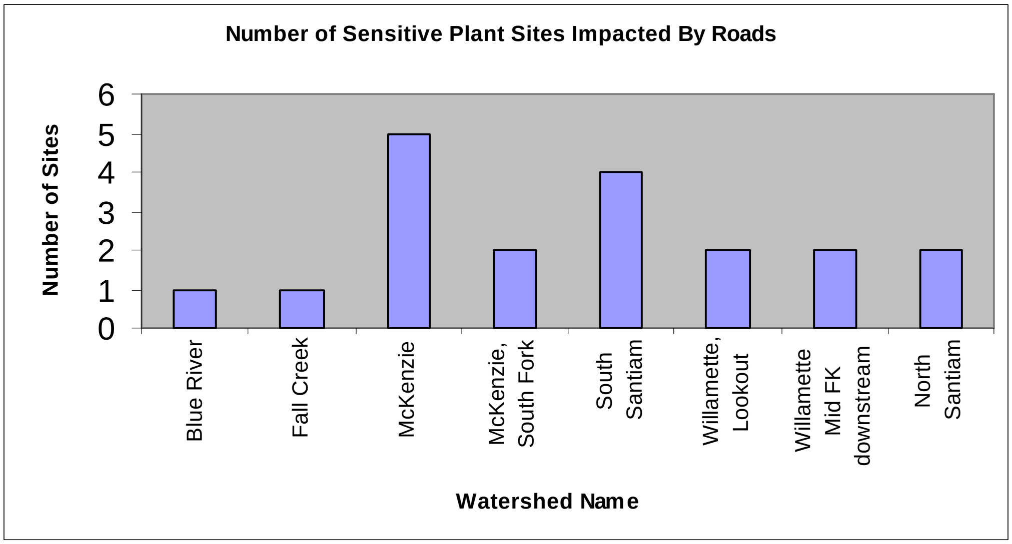
This scale of analysis shows the effect of road construction on diverse plant habitats. Habitats particularly affected by roads and associated quarries and disposal areas tend to be rock gardens and mesic to dry meadows and shrub talus found along ridgelines. This type of analysis may be used by resource specialists to determine restoration needs and priorities for special habitats at the watershed scale, to be implemented at the project scale.

Sensitive Plants

The only known population of a sensitive plant that has been directly affected by road construction in the 1980's is *Aster gormanii*, Gorman's aster (see Figure 1, North Santiam). This species grows along ridgeline scree slopes on Detroit and Sweet Home Ranger Districts. A spur road was placed through a section of one population. Results of this action are difficult to determine as the population was not monitored prior to road construction.

The most commonly affected sensitive plant is *Romanzoffia thompsonii*, Thompson's mistmaiden, in rock gardens adjacent to roads on Detroit, McKenzie, Middle Fork and Blue River Ranger Districts (see Figure 1). This species is an ephemeral annual that blooms during the spring when runoff moistens its habitat. Adverse effects to the populations probably occurred during the period of road construction. However, that construction led to the discovery of most of these populations. In all cases, roads are below the population and do not obstruct drainage; the chance of the road adversely affecting this species is minimal. In some cases (McKenzie South Fork in particular), road maintenance should take into consideration the close proximity of the population.

Figure 1. Number of TES Plant Sites Impacted By Roads/Watershed



The only other issue where road use could affect mistmaiden would be increased access to the site by having the road situated so close to the populations.

Four populations of tall bugbane, *Cimicifuga elata*, are found near roads. All of these subpopulations occur in the central core of the population, in the South Santiam watershed (Figure 1). This species occurs in mixed coniferous/deciduous forests at low to moderate elevations in the Cascades. It is tolerant of shade, but benefits from opening of the canopy (Kaye and Kirkland, 1994). One population has a skid road running through its center, providing a road for travelling deer and elk who find this rare plant a favorite food. Recommendations for these roads would be to allow them to revegetate themselves with no further disturbance.

Umpqua swertia, *Frasera umpquaensis* is found adjacent to a road at the headwaters of the Fall Creek drainage (Figure 1). A ridgeline road (1824/142) was built through the meadow community that provides habitat for this plant. It is unknown if the road decreased the population size; a subpopulation is less than 15 feet from the road (1824/142). Maintenance of this road should take into consideration affects to this species. Because this system is frequently used, restoration of the meadow is probably not realistic.

The final sensitive plant affected by roads is an odd ephemeral vernal pool species called *Montia howellii*, Howell's montia. This species grows in mud puddles in the parking lot of a very heavily used trail(Figure 1, Lookout Point). Plants are only discernable in February-April. After the rainy season ends, pools dry up and plants die. Recommendations for managing this site would include no grading activities that would fill up those pothole habitats. Other options would include not using the parking lot where the plants are located until April.

Late Successional Species

A number of survey and manage species have the potential to be affected by roads. The species are classified into four types: vascular plants, bryophytes, lichens and fungi. Life histories differ dramatically for these species, management recommendations for each species group will differ.

Table 4 shows the only vascular survey and manage species adjacent to roads is *Allotropa virgata*, candystick. This species is mycotrophic; it has no chlorophyll so it attaches itself to a host tree roots for food via a mycorrhizal fungus. Experiments in the Umpqua National Forest (Dan Luoma, pers. comm.) have shown that similar mycorrhizal species can tolerate commercial thining; a closed old growth canopy is not necessary for maintenance of the species. Changes to the microclimate created by roads should not affect this species. Only direct impacts to the mycorrhzal symbiont or host trees would adversely affect candystick.

The bryophytes featured in Table 4 are very different from one another. *Buxbaumia viridis* grows on decomposing class 3 or 4 logs. It is sensitive to changes in light level and microclimate caused by removal or thinning of the canopy and is dependent on adequate levels of coarse woody debris (Bryophyte Management Recommendations, *Buxbaumia*, p. 2) *Racomitrium aquaticum* is a bryophyte which grows on rocks on or near streams. *Racomitrium* would be vulnerable if road culverts were removed and extra sediment washed downstream. This species is also vulnerable to erosion and scouring floods that could remove the species from its substrate (Bryophyte Management Recommendations, *Racomitrium*, p. 2). If populations of this species are located in areas of potential road failures, this would represent a "hot spot" for survey and restoration (see map ef1c- aquatic bryophytes).

Table 4. Survey and Manage Species Affected By Roads

Species Group	Species	Survey Strategy	**Populations Affected by Roads**
Vascular	*Allotropa virgata*	1,2	20
Bryophyte	*Buxbaumia viridis*	Protection Buffer	1
	Racomitrium aquaticum	1,3	1
Lichen	*Bryoria subcana*	1,3	1
	Fuscopannaria leucostictoides	4	1
	Fuscopannaria saubinettii	4	2
	Hydrothyria venosa	1,3	2
	Hypogymnia oceanica	1,3	8
	Lobaria hallii	1,3	4
	Lobaria oregana	4	9
	Lobaria pulmonaria	4	11
	Lobaria scrobiculata	4	3
	Nephroma bellum	4	3
	N. helveticum	4	4
	N. occultum	1,3	3
	N. parile	4	3
	Peltigera collina	4	6
	Pseudocyphellaria anomala	4	12
	P. anthraspis	4	10
	P. crocata	4	3
	P. rainierensis	1,2,3	3
	Sticta fuliginosa	4	2
	S. limbata	4	1
	Usnea hesperina	1,3	1
	U. longissima	4	1
Fungi	*Boletus pulcherrimus*	1,3	1
	Choiromyces alveolatus	1,3	1
	Destuntzia fusca	1,3	1
	Geelatinodiscus flavidus	1,3	1
	Gymnopilus puntifolius	1,3	1
	Mycenia monticola	1,3	1
	M. quinaultensis	1,3	1
	Neournula pouchettii	1,3	3
	Pithya vulgaris	1,3	2
	Rhizopogon inquinatus	1,3	2

Most of the species in Table 4 are lichens. Most are old-growth associates which depend on maintenance of interior habitat with associated temperature and humidity regulation (USDA and USDI, 1994b, p. 231) because of their epiphytic habit. Epiphytes are species that grow in the canopy of trees without rooting in soil. They depend on the air for moisture and nutrients. When specific species have been transplanted experimentally to the edge of clearcut stands, these species reproduced poorly and viability was low (USDA and USSDI, 1994b, p. 231). A prioritization of closing and revegetating roads within late-successional reserves should benefit these species viability (see wildlife discussion on maintenance of interior habitat for late-successional species).

Other lichens are associated with riparian areas. *Hydrothyria venosa* is an aquatic lichen. As mentioned above in the *Racomitrium* discussion, care should be taken with restoration projects around populations of this species due to affects from increased sediment loads (see map ef1c- aquatic lichens). “This lichen appears to be more sensitive to stream sediment than are salmon” (USDA and USDI, 1994b Appendix J2, p.243). Populations of *Hydrothyria* located in areas with potential road failures or in areas scheduled for road reconstruction should be considered “hot spots”.

Usnea longissima is an epiphyte on hardwoods. The increased humidity within riparian zones is critical to maintenance of this species (USDA and USDI, p. 239). Restoration and closing of roads within riparian areas in late-successional reserves should aid in maintaining species viability (see wildlife section on interior habitat).

The final group of survey and manage species are the fungi (Table 4). Most are mycorrhizal species, connected underground to host tree roots that supply some nutrients while the fungus provides macronutrients from the surrounding soil (and maybe some other benefits such as disease resistance). Some are truffles (*Rhizopogon*) which fruit underground but are also mycorrhizal. Others are cup fungi (*Gelatinodiscus*, *Pithya*) which grow out of twigs or needles. Green hazard tree removal could affect some fungi in removing their hosts. Road maintenance activities outside of the road prism could compact soil and kill fungi.

Table 5 depicts the number of survey and manage species affected by roads within 6th field watersheds. The McKenzie and Willamette, Lower North Fork Middle Fork have Survey and Manage Species Impacted By Roads By Watershed the highest number of affected species and would be considered “hot spots”. However, these watersheds are both large in size and do not have a greater density of survey and manage species/area than other watersheds presented.

Table 5. Number of Sites Affected by Roads

Watershed Name	Number of Sites
Breitenbush	9
Upper North Santiam	1
Quartzville	2
Middle Santiam	4
South Santiam	10

Watershed Name	Number of Sites
McKenzie	37
Blue River	5
Horse Creek	1
South Fork McKenzie	6
Winberry	3
Willamette, Lower N Fk	34
Willamette, Upper N Fk.	1
Salmon Creek	6
Salt Creek	2
Willamette, Mid Fk Downstream	13
Willamette, Upper Mid Fk	10

Noxious Weeds

The analysis of noxious weeds using GIS layers focused on new invader weed populations. Established weed infestations would be found along most road corridors making analysis of hot spot areas impossible.

Table 6 shows the number of new invaders affected by road corridors. The majority of new invaders documented on the Forest is associated with a road. Roads are vectors for dispersal of weeds. Additional standards and guidelines for the Willamette Land and Resource Management Plan are proposed in a new Environmental Analysis for Integrated Weed Management for prevention of weed movement along road corridors:

- Immediately seed (with native species where possible) roads following construction, removal or maintenance, using a competitive cover to discourage weed movement.
- Require that vehicles used under contract (such as logging, road construction and stream restoration equipment) be steam cleaned prior to movement from one project area to another (used as a contract clause for ground-disturbing activities).
- Use only certified weed-free seed for revegetation purposes. Try to use native, non-invasive seed.
- Use only weed-free rock sources for road construction/restoration projects
- Close roads to reduce the number of weed travel corridors on the Forest.

In a Master's theses conducted on HJ Andrews Experimental Forest (Blue River watershed, Parendes (1998) found that closed roads have less or no weeds as compared to roads that remain open. A serious effort should be undertaken, via ATM, to document necessary roads and close those which do not contribute to necessary activities. Even gates provide the decrease in disturbance necessary for native species to reinvade and outcompete weedy species (Ford, pers. comm.).

Table 6 Number of New Invader Weed Sites Located Adjacent to Roads

Weed Species	Number of Sites
Spotted knapweed	76
Himalayan and Evergreen Blackberry	55
Meadow knapweed	15
Yellow toadflax	7
False brome	6
Diffuse knapweed	5
Giant knotweed	3
Dalmatian toadflax	1
Houndstongue	1

The number of new invading weeds located in watersheds throughout the Forest varies, depending on the density of roads and number of highway travel corridors found within the watershed. Blackberry sites are not included in **Table 7** because surveys are not consistent forestwide. The McKenzie, Willamette Middle Fork Dowstream Tribs and South Santiam watersheds have the highest density of weed infestations. The McKenzie corridor is highway 126. In the past 5 years we have noted significant movement of spotted knapweed from this highway corridor on to secondary Forest Service roads. As spotted knapweed continues to be spread by vehicles coming from the east side of the Cascades and as road maintenance activities continue to move weed seed around with cinder for icy roads, this trend will continue. The South Santiam watershed, through which highway 20 runs, is in a similar situation. The Willamette Middle Fork Downstream tributaries is an area accessed by highway 58, another highway corridor which crosses the Cascade crest. Expansion of populations here, along roads 21 and 23, are probably due to recreation, such as dispersed camping and hunting, as well as equipment used in timber harvest activities. These areas should be considered “hot spots” for weed infestation. Road projects should include costs associated with weed prevention in their budgets (see measures outlined above). An option to address recreational user spread of weeds would be to close dispersed campsites and hunting camps with documented weed infestations until they are “cleaned” of existing weed infestations.

Table 7. Number of New Invader Weed Populations By Watershed

Watershed Name	Number of Weed Sites
McKenzie	24
McKenzie, South Fork	12
Willamette, Mid Fk Downstream	12
South Santiam	10

Watershed Name	Number of Weed Sites
Willamette, Upper Mid Fk	8
Salt Creek	5
Willamette, Lower N Fk Mid Fk	5
McKenzie, Minor Tribs	4
N. Santiam, Upstream Tribs	4
Salmon Creek	4
Blue River	3
Fall Creek	3
N. Santiam, Blowout-Woodpecker	3
Quartzville	2
N. Santiam, Downstream	2
Willamette, Lookout	2
Hills Creek	1
Horse Creek	1

Process Critique

The timeline for this analysis was too short. Tell the story part was a very valuable step in getting ideas on analysis from other members of the Team. We had only one person doing all the GIS requests and it was too much for one person given time constraints. I received my final data requests after the integration step had taken place. Botanical issues were largely left out of this step as a result of this lack of data.

Data consistency and availability as well as questions of scale always confounds analysis. Using forest-level, generalized data to analyze special habitats did not work. Data on special habitats at the District scale is much more telling of the effects of roads on these species. Data on sensitive species is very good and an analysis of effects can be done at the forest scale. Inventory for survey and manage species is in its infancy. Data collected tends to be in areas of project activity so Late-Successional Reserves and other reserve areas may be underrepresented in distribution. Analysis is appropriate at the forest scale. Data on weeds is good for all new invaders except blackberry. Analysis at the Forest or province level might be most appropriate for weeds which move along major highway corridors although prevention measures to stop movement of the weeds needs to be local. This means Forest Service road maintenance contractors and contractors for ground-disturbing activities need to be educated as to the effect they are having on movement of weeds across the Forest and measures they can take to stop the spread.

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